ME – 23

THE IMPLEMENTATION OF OPEN-ENDED APPROCH FOR IDENTIFYING STUDENT WORK PATTERNS ABOUT AREA CONCEPT

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Abstract

The purpose of this study is describing the patterns of students work in area problems. The background of the study is students are still having difficulty in chosing the right strategy to find area. The method is developing "best practice". The subjects are 17 students of mathematics education program . They come from different provinces of Indonesia. The best practice is done by (a) discussing the types of open strategies, and (b) working open-ended subjective test. The results gets the answer patterns . From problem one, there are nine students with right answers, and eight students with wrong answer. The patterns of right answers are six students work by combining parts, and three students work by subtracting the hole area by parts. The patterns of wrong answers are four students work by combining parts with mistake in calculation, three students make conceptual mistake, and one student work by subtracting the whole by parts with mistake in calculation. From problem two, there are eight students with right answer, and 11 students with wrong answer. The patterns of answers are combining parts, subtracting from the whole, using similarity, and applying Pythagorean Theorem. The fact shows that there is the growth of critical and creative of mathematical thingking..

Key Words: study, open-ended, area, work pattern.

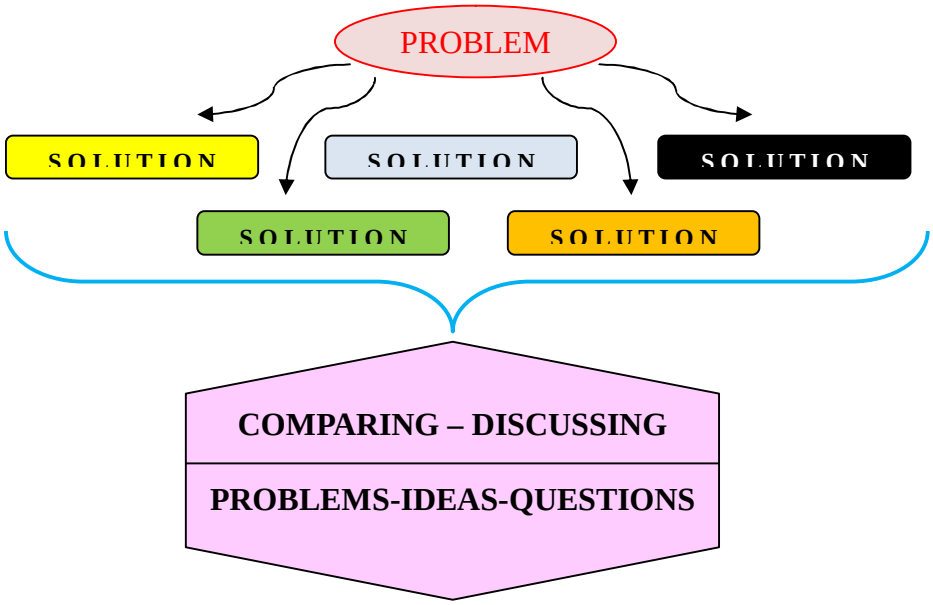
INTRODUCTION

It is clerly stated in the Republic of Indonesia Constitution Number 20 Year 2003 about National Education System Chapter 39 Article (2) that educaters (including teachers) , is a professional manpower to deliver learning process (Kemendikbud, 2003). According to the Republic of Indonesia Constitution Number 14 Year 2005 Chapter 4, as professional menpower, the central position teachers is the agent of reforrmation for increasing the quality of national education. (Kemendikbud, 2005), and it is stated in (a) Chapter 10 Article (1) that teachers must have professional competency, and in Chapter 32 that their professional competency must be established and developed such that they become kowledgable and skillfull about their profession. Based on The Decree of Minister of Education The Republic of Indonesia Number 16 Year 2007, two of five standards of professional competencies are (a) mastering the knowledge of mathematics to support school mathematics teaching material, and (b) creatively implementing and practicing school mathematics teaching material (Kemendikbud, 2007).

Learning to be a professional knowledgable and skillfull teachers needs a long series of activities, tranings, and practices. Arends, R.I. dan Kitcher Ann (2010) states that as professionals, teachers are expected to use best practices to help their students learn essential ways in solving problems. There is a new movement outlook that in this 21st century, the essential role of teachers are construvtivist learning designer (Gagnon, G.W. and Collay, M, 2009: 3). It means that techers should give students a lot of opportunity to develop habit of reasonable thingking in solving and working (mathematics) problems. The habit of reasonable or higher order thingking consist of crative thingking, critical thingking, and self regulated thingking (Marzano, R.J. & Pickering, D.J., 2012). It is also said by Kemp, J.E., Morrison, G.R.

& Ross, S.M. (….) that one of nine elements for delivering learning process is identifying learning content of subject matter (mathematics) which can be studied by relating it to strategy or method in which students get experience in systematic higher order thingking. Open-ended learning style is a model, strategy, or method of learning to promote habit of mind in higher order thingking.

The meaning of open problem can be separated with closed problem. It is a fact that many a lot of mathematics teachers are believed to "operate" closed problem in delivering learning process. They use problem with single solution or single method of solution. Pehkonen (1995) defines closed problem as problem that does not have more than one answer or more than one method of solution. It means that the possibility of divergent thingking is not permitted in solving problem. On the other hand, open problem make students to go beyond the usual way since students are push, motivated, or challenge to reveal right answer or better solution different with ather solutions. This approach is said open-ended since it is ended with open solutions and/or ways of finding solutions. It is first used in Japan around 1970s. Researchers in Japan implemented open-ended themes to grow and to accustom as higher order thingkers. In general, according to Takahashi, A. (2006), the characteristic of mathematics learning process is said **structured problem solving,** and it can be diagrammed as follows:



Research studies show that using open-ended approach have positive effect on the quality of mathematics learning process. Al-Absi, M. (2012) stated that open-ended tasks had a positive effect on improving students' achievement. Floriana, V. and Oliviera, I.B. (2013) showed that open-ended task promoted cjassroom communication because it changed student attention and encouraged students to ask each other. Kwon, O.N., Park, J.S., and Park, J.H.

(2006) indicated in their research study that open-ended approach cultivated divergent mathematical creativity thingking. The mathematical creativity thingking was identified by three indicators: fluency, flexibility, and originality.

In 2014, the master program in mathematics education in State University of Malang had a special course. The course title was Selected School Mathematics. The aim of the course was providing students the ultimate trends in delivering school mathematics. The participants or students of this course were 17 mathematics teachers or candidate of mathematics teachers. They came from six difference provinces in Indonesia , nine of them graduated from state universities, and eight of then graduated from private universities. So, it is assumed that they have different capacities of knowledge in mathematics and in delivering school mathematics. It

was identified before that their knowledge about mathematical open-ended problems were very poor. That was why one of the given topics to be chosen was open-ended approach in mathematics learning process. The learning process was intended to provide students teachers knowledge, theoretically and in practice, about open-ended approach in mathematics learning process. It was hoped that this experience would influence, and then change their outlook or perspective, attitude, and mind set in delivering school mathematics in the next future.

DISCUSSION

The subjects of this best practice are 17 students of Selected School Mathematics. They are in progress to finish study to get master in mathematics education. They come from six different provinces: one student from North Sulawesi, one student from Middle Sulawesi, one student from South Sulawesi, one student from East Kalimantan, one student fron South Kalimantan, two students from West Sumatra, and 10 students (from five districts) from East Java. It is also known that they graduated from state universities (eight students) and private universitie (nine students). From their back ground can be understood that their knowledge of mathematics and mathematics education are very heterogen. They must have the same perception about new trends of better delivering school mathematics. One of the topics that is viewed very essential is everything about open-ended in learning mathematics. This topic is chosen since it can be used to make students have mind habit in higher order thingking.

At first, they are given activity to develop the concepts of open-ended problems by revealing easier and simpler special mathematics problems. The activity to solve the open-ended problem is meant to motivate the sense of divergent thingking by introducing the main idea of open-ended problem, and making them to be familiar with open-ended problem.

(a) Find the sum of 78 + 95 and explain how do you find the answer
(b) Find the sum of 1 + 2 + 3 + … + 9 and explain the way to find the answer
(c) Find the base and the height of a triangle if its area is 24 cm^2

In solving the problems indidually, it is known that most student still have “old” way to get the answers. Problem (a) is done as usual by applying vertical method:

$$\begin{array}{r} 78 \\ 95 \\ \text{----} + \\ 173 \end{array}$$

They are asked to involved in class discussion by challenging them to use different ways, and chosing which one of the ways is the better way. They begin realize that there are many ways to solve this addition problem:

78 + 95 = (70 + 8) + (90 + 5) = (70 + 90) + (8 + 5) = 160 + 13 = 173
78 + 95 = (75 + 3) + (75 + 20) = (75 + 75) + (3 + 20) = 150 + 23 = 173
78 + 95 = 78 + (2 + 93) = (78 + 2) + 93 = 80 + (90 + 3) = (80 + 90) = 3 = 173
78 + 95 = 78 + (22 + 73) = (78 + 22) + 73 = 100 + 73 = 173
78 + 95 = (73 + 5) + 95 = 73 + (5 + 95) = 73 + 100 = 173

Problem (b) is also done as usual by adding the numbers from the first to the last:

1 + 2 = 3
1 + 2 + 3 = 3 +3 = 6
1 + 2 + 3 + 4 = 6 + 4 = 10
1 + 2 + 3 + 4 + 5 = 10 + 5 = 15

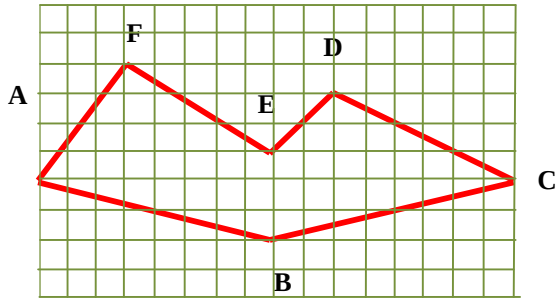
Some of the students are working with the rule in arithmetic series. No one of them is trying to find out "new" way by combining two or more specific numbers, such as:

$(1 + 9) + (2 + 8) + (3 + 7) + (4 + 6) + 5 = 10 + 10 + 10 + 10 + 15 = 4.10 + 5 = 45$
$(2 + 9) + (3 + 8) + (4 + 7) + (5 + 6) + 1 = 11 + 11 + 11 + 11 + 1 = 4.11 + 5 = 45$
$(1 + 8) + (2 + 7) + (3 + 6) + (4 + 5) + 9 = 9 + 9 + 9 + 9 + 9 = 5.9 = 45$
$(1 + 2 + 3 + 4 + 5) + (6 + 9) + (7 + 8) = 15 + 15 + 15 = 3.15 = 45$

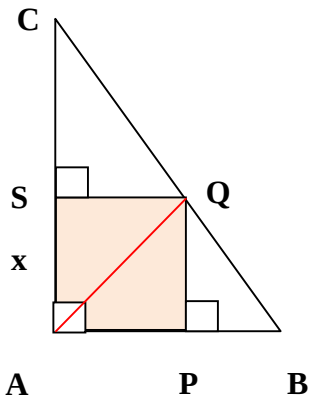
In combining numbers, two or more numbers whose sums, differences, products, or quotients are easy to calcalute mentally is said **Compatible Numbers.** (Musser. G.L., Burger, W.F., & Peterson, B.E., 2004: 154).Some different examples are given for making students understand the principles in implementing open-emded problems, and for giving students a lot of experience to practice in developing and solving open-ended problems.
Problem (c) is done better since students have obtained the essential idea of of open-ended approach. They immediately decide that they have to determine two factors of 48. If the triangle has the base b and the height t then $\frac{1}{2}$ bt = 24 , so bt = 48.

After practicing many problems with differet kind of types of characteristics, they are given two-item specific test:

1. Find the region area of ABCDEF in unit square of the grid

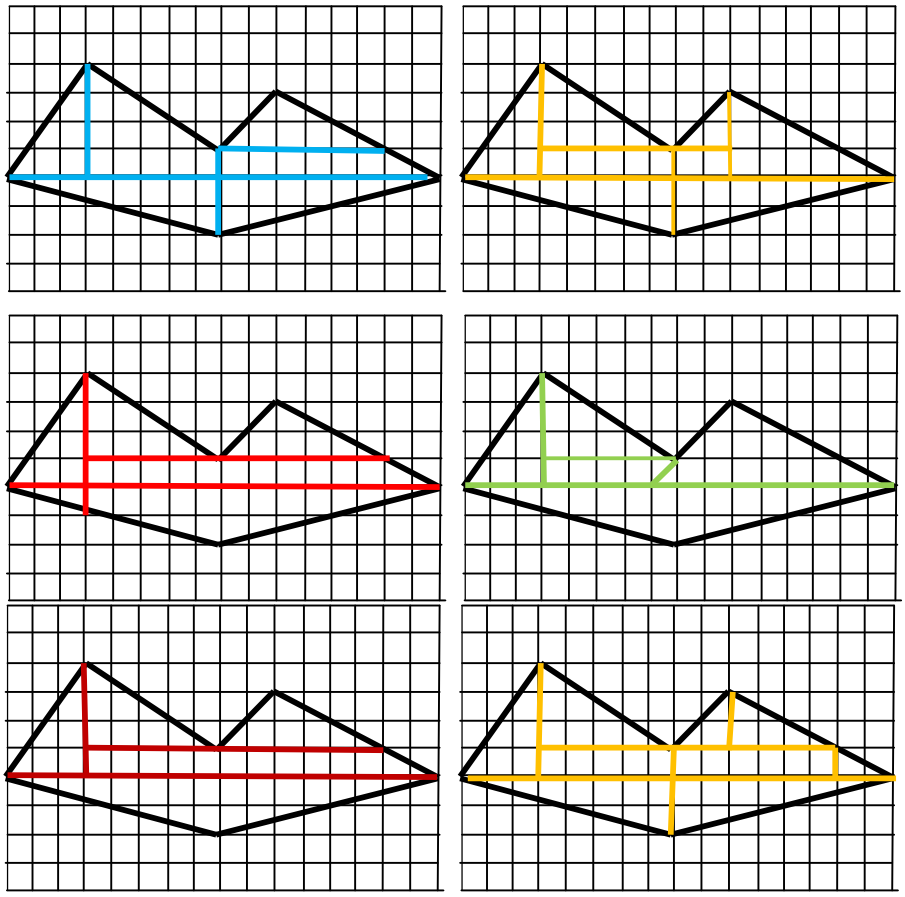


2. Find x if AB = c and AC = b

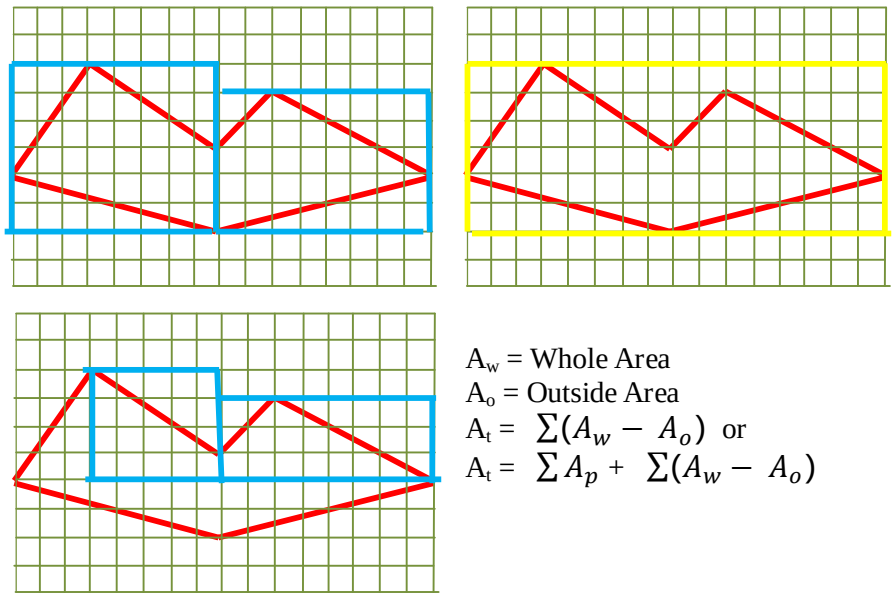


Problem 1
The Patterns of The Right Answers
There are nine students who did right answer, and eight students who did wrong answer. From the right answers can be identied that the area can be found by (a) combining and adding parts area, and (b) determining areas as specific shapes and subtracting it by the areas of parts outside the objects or the target. The types of their answers can be presented as follows:

(a) The ways in separating the parts area are vary and interesting. They make parts by considering that each shape area can be calculated with the easier right rule. If A_t = Total Area and A_p = Parts Area , then $A_t = \sum A_p$. It is tricky and not always easy to determine separable and measurable of parts area.



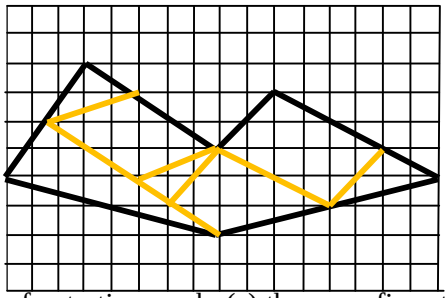
(b) The ways in taking whole area are very creative and critical.



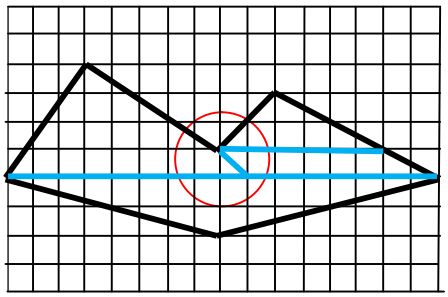
A_w = Whole Area
A_o = Outside Area
$A_t = \sum(A_w - A_o)$ or
$A_t = \sum A_p + \sum(A_w - A_o)$

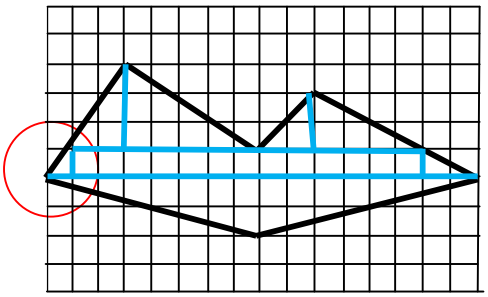
The Patterns of The Wrong Answers

From the eight students who did wrong answer, (a) there is one student who make mistake in calculation (double counting), (2) there is one student who make conceptual error because this student does not completely understand the way to separate the shape area into different parts shapes, each part of the shape must have measurable area:



This is the most disappointing or frustrating work, (c) there are five students who slip in making reasoning to divide the shape into different measurable shapes, and some of their mistakes are:





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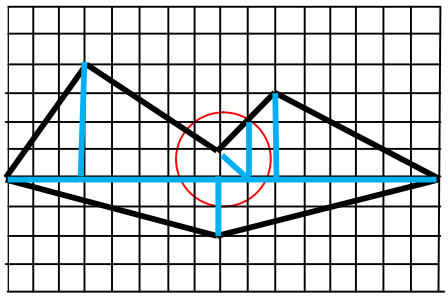
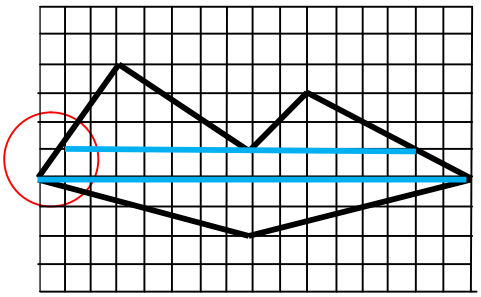
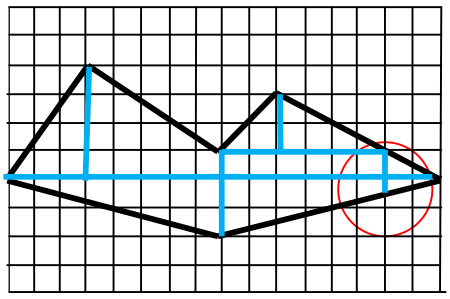


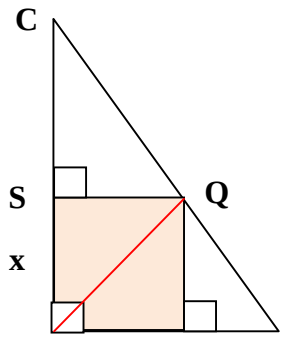




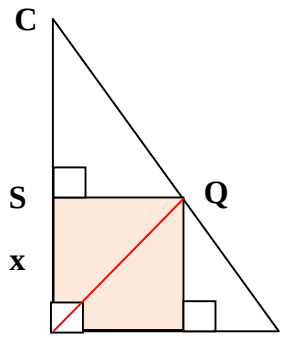
Problem 2

It is hoped that they can use area concept for finding the length of the square side (the area of the square is equal to the difference of the whole area of the bigger triangle and the sum two smaller triangles). They are also given open opportunity to use other ways whatever they can

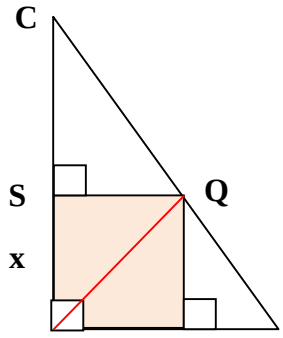
find it. From the nine students who do right in answering problem one, there are five of them can do right answer in solving problem two. From the eight students who do wrong in answering problem one, there are three of them can do right answer in solving problem two. The pattern they solve problem two can be classified as using area, using similarity of triangles, and using combination of Pythagorean Theorem and triangles similarity. The work of them as follows:



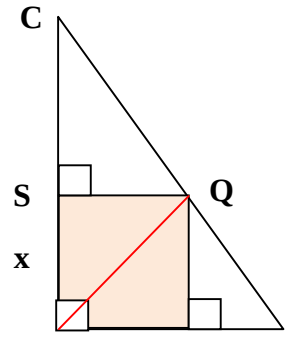
$A_{ABC} = A_{SQC} + A_{APQS} + A_{PBQ}$



$A_{APQC} = A_{ABC} - A_{SQC} - A_{PBQ}$



(3) $\Delta ABC \cong \Delta SQC$, $\Delta ACB \cong \Delta PQB$



(4) $(BQ + QC)^2 = AB^2 + AC^2$

CONCLUSION AND SUGGESTION

The result of this best practice shows that the open-ended mathematics learning process has its potential power to foster students in higher order mathematics thingking. This way can motivate the growth of thingking creatively, thingking critically, flexible thingking with meaningful reasoning, and working independently. It is a real fact that the kind of experience in solving open-ended problems will increase the students' sense to change their old (traditional) mind set to have open-ended learning habit.

Indonesian students need a lot of experience in solving open-ended problems. The experience of the students can be developed and implemented together with the effort to increase the professional development of mathematics teacher. The open-ended teaching approach can be taken as one of choices because it is recognized as a good lesson (Becker, J.P. & Shimada, S., 1997). It is also stated by Miyakawa, T. (2006) that good (best) practices refers to good approach for teaching in the classroom such that students have the opportunity to involve in constructing their knowledge. It is understood that the open-ended approach is put into the framework of professional development of mathematics teachers (Inprasitha, M., 2006).

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